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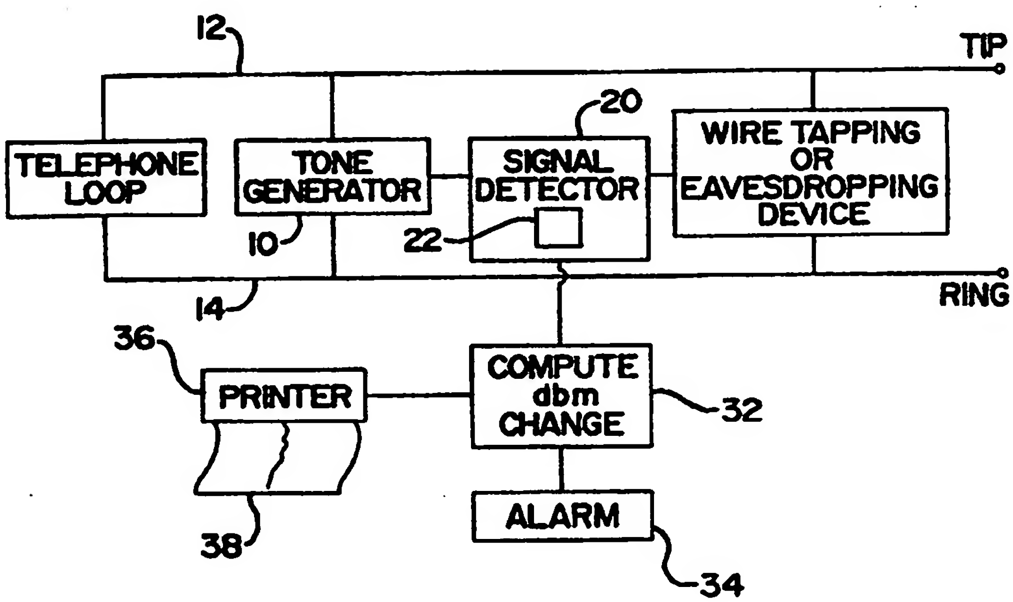
(54) Title: APPARATUS AND METHOD FOR DETECTING EITHER A FAULT OR AN UNAUTHORIZED TAP IN A TELEPHONE LINE



(57) Abstract

An apparatus and method for determining an abnormal condition of a telephone line (16). A tone generator (10) applies a signal having a frequency of at least 20,000 hertz to the telephone line (16) to determine a reference frequency loss under normal conditions. The same tone generator (10) can apply a similar signal to the telephone line (16) to determine an abnormal decibel loss under abnormal conditions using the signal detector (20) and dbm computational device (52). The difference in the decibel loss indicates the abnormal condition of the telephone line (16).

APPARATUS AND METHOD FOR DETECTING EITHER A FAULT OR AN UNAUTHORIZED TAP IN A TELEPHONE LINE

This invention relates to means for detecting either fault or an unauthorized tapping of a telephone line, and more particularly to a method for detecting a change in frequency of a tone generated over the telephone line caused either by a discontinuity in the line or an unauthorized tapping.

Telephone lines frequently experience faults which may be caused by a variety of sources, such as a buried line being severed by earth moving equipment and the like. One of the problems with such faults is that it is difficult to precisely locate where the fault has occurred. For example, if the line is buried underground, and conventional equipment determines that there is a problem some place along several hundred feet of line, the line repairman has the difficult job of pinpointing the precise location of the discontinuity. If the line is above ground, he may have to progressively climb a series of telephone poles before be can pinpoint the problem. If it is buried, the problem is compounded.

Another problem with telephone lines is the concern for unauthorized telephone line tapping, whether legal or illegal. Some tap detection devices are known in the prior art. See, for example, United States Patent No. 4,634,813 issued January 6, 1987, to Robert P. Hensley for "Wire Tap Detection Device"; United States Patent No. 5,142,560 issued August 25, 1992, to Mark J. Neer for "Wiretap Detector and Telephone Loop Monitor"; United States Patent No. 4,680,783 issued July 14, 1987, to Eduard F. B. Boeckmann for "Telephone Security Violation Detection Device"; United States Patent No. 5,287,404 issued February 15, 1994, to David A. Pepper et al. for "Telephone Subscriber Line Voltage Change Detection"; United States Patent No. 4,760,592 issued July 26, 1988, to Robert P. Hensley for "Wire Tap Detection Device with Passive Testing"; and United States Patent No. 5,099,515 issued

March 24, 1992, to Osamu Kobayashi et al. for "Secrecy Device for Wiretapping Prevention and Detection". These devices are connected to a telephone line for measuring the values of polarity and electrical characteristics of the telephone line, and commonly apply a signal having a frequency in the range of 4,000 to 5,000 hertz. This frequency range is commonly used because it is the range in which most telephone equipment or tapping devices operate.

Such detection devices generally are inaccurate. When a tone generator is used for detecting wire taps in this frequency range, the loss in frequency is such that the device is unable to detect any meaningful signal representing an unauthorized tap.

It is a desideratum of the present invention to avoid the animadversions of the prior art.

SUMMARY OF THE INVENTION

The term "abnormal condition" as used herein means a discontinuity in a telephone line, the presence of unauthorized equipment connected to the telephone line, line transmitters, i.e., bugs placed inside the telephone or on the line, extension line eavesdroppers, all voltage activated devices, automatic telephone tape recording devices, volts in the telephone system, etc.

The present invention provides an apparatus for detecting an abnormal condition of a telephone line, comprising first means for applying to the telephone line a signal having a frequency of at least 20,000 hertz. The apparatus also includes second means for determining a reference decibel loss in the telephone line under normal conditions when said signal is applied to said telephone lines. The apparatus also includes third means for determining an abnormal decibel loss in said telephone line caused by said abnormal condition when said signal is applied to said telephone line. The difference between said reference decibel loss and said abnormal decibel loss indicates the abnormal condition of said telephone line.

The present invention also provides a method for detecting an abnormal condition of a telephone line, comprising the steps of applying to said telephone line a signal having a frequency of at least 20,000 hertz, and determining a reference decibel loss in said telephone line under normal conditions when said signal is applied to said telephone line. The method also includes the step of determining an abnormal decibel loss in said telephone line caused by said abnormal condition when said signal is applied to said telephone line. The difference between said reference decibel loss and said abnormal decibel loss indicating said abnormal condition of said telephone line.

The broad purpose of the present invention is to provide an apparatus and a method for testing a telephone line for either determining the location of a fault in the line, or the presence of unauthorized equipment connected to the line. For wire tap purposes, the device is designed to measure frequency changes in working and non-working telephone pairs between a test location and a local switching office. The test apparatus includes a transmitter and a receiver with a tone selection of 20,000 hertz or greater, with a digital display capability. Typically, most telephone lines comprise two copper twisted wires. If the user intends to use the equipment for locating a fault in the line he connects the tone generator to the tip and ring lines and transmits a tone of 20,000 hertz or greater. The device has a receiver which monitors the reflection of the tone frequency and preferably has a digital read out indicating the decibel drop in the tone. For illustrative purposes, the drop in the audible signal may be assumed to measure a 7.0 decibel measurement loss (dbm).

Assuming the normal decibel drop for a telephone line is 7.0 for a particular subscriber, if the subscriber takes a reading which measures 7.3, then the 0.3 added drop is proportional to the distance from the test site to the location of possible fault. Assuming there is a 0.1 loss for every hundred feet, the user can determine the location of the fault at 300 feet.

This would tell the repair crew where to locate the fault in the interrupted telephone line.

Employing unconventionally higher frequencies, that is 20,000 hertz or above gives a greater dbm loss range, which in turn improves the precision of the device. The use of a frequency lower than 20,000 hertz gives false readings because the frequency is too low.

For purposes of determining the existence of a telephone tap on a telephone line, the user initially applies a test tone to the line at 20,000 hertz or greater to determine a base or normal frequency loss measured in terms of the decibel loss. Knowing this he can periodically test the line to determine if there is either an increase or a reduction in the frequency loss. If somebody is tapping the line, the tapping equipment, because of the added copper wire or equivalent, will reduce the frequency. If the eavesdropper is using a voltage activated device, the dbm reading will drop. In addition to the more precise reading of the existence of a tap, using a frequency of 20,000 hertz or greater transmits a signal that cannot be detected by the equipment normally used by an unauthorized tapping agency, whether legal or illegal.

Still further objects and advantages of the invention will become readily apparent to those skilled in the art to which the invention pertains upon reference to the following detailed description.

Description of the Drawings

The description refers to the accompanying drawings in which like reference characters refer to like parts throughout the several views, and in which:

FIGURE 1 is a system block diagram of a telephone system illustrating how a fault in the telephone line may be located;

FIGURE 2 is a block diagram of a telephone security tapping detection system illustrating the invention;

FIGURE 3 is a diagram illustrating how the tone generator attaches to the twisted

copper wires on the telephone line; and

FIGURE 4 is an electrical schematic of a preferred embodiment of the present invention.

Description of the Preferred Embodiment

Referring to Figure 1, a circuit has been shown in block diagram form. A system tone generator 10 is connected between a tip line 12 and a ring line 14 of a telephone loop 16. The connection of the tone generator 10 may be in any suitable location in the circuit either at the telephone or with the telephone disconnected. The device may be a feature of a single line telephone, multiple link telephones and any telephones being served by a KSU or a phone switch. It can also be a feature in the connecting block for either desk or wall phones. The tone generator 10 must generate a tone with a frequency of at least 20,000 hertz. Frequencies in the range of 5,000 to 10,000 hertz, commonly used in telephone system equipment, will not produce an accurate signal and in many cases produces no signal at all.

Referring to Figure 3, a tone generator 10 is connected to the tip and ring lines 12 14, respectively, which are copper wires twisted together as illustrated. However, to be more precise, the apparatus 40 comprises a tone generator 10, a signal detector 20, and a RMS to DC converter with power supply.

Assuming that in a line several hundred feet long the absence of a dial tone indicates that a break in the line caused by some means, the user generates a tone into the lines which by virtue of self-inductance causes a drop in the frequency which will be reflected in signal detector 20. Detector 20 digitizes the signal to produce a dbm reading in a visual device 22. Dbm is a common term used to refer to the decibel loss in the telephone line. The loss is then compared to that of a normal line. If the normal loss has not been determined before the fault occurred, then it may usually be determined by generating a tone in a neighboring line which

does not have a fault.

Assuming the normal loss is 7.0 dbms and the present abnormal condition loss if 7.3 dbm, the difference is 0.3 dbms. The location of the loss, that is the distance from the test site to the fault in the line, may then be determined by a formula which uses the standard loss per foot of line. For example, in the same line, a 0.1 dbm loss occurs in a hundred feet of line. A 0.3 dbm loss then indicates that the fault is 300 feet from the test site. The repair crew can then fairly precisely locate where the repair must be made.

Figure 2 illustrates another application of the invention. In this case, the block diagram shows a tone generator 10 connected to the tip and ring lines 12 and 14, respectively, of the telephone loop 16. The signal detector 20 is also connected across the tip and ring lines 12 and 14, respectively, or may be combined in some way with the tone generator 10. Normally there is no unauthorized tapping activity across the line.

The user calculates a base decibel drop across the ring lines by generating a tone in excess of 20,000 hertz. Assuming that this results in a base line dbm of 7.0, the user either periodically connects a tone generator 10 and signal detector 20 across the line to determine the instantaneous status of the line, or provides a permanent connection of these devices on the line to provide a continuous status reading. Unauthorized tapping equipment 30 that has been connected across the tip and ring lines 12 and 14, respectively, will then create a change in the dbm, either an increase or a reduction, depending upon the nature of the tapping equipment 30.

The user upon noticing the change can then take corrective steps. The user can employ a computer device 32 which is so connected to the signal detector 20 as to provide a continuous monitoring of the status of the line. Upon detecting a predetermined change in the dbm, device 32 can then energize an alarm 34.

In the alternative, computer 32 could be connected to a form of a printing device 36 which could then determine the time the unauthorized tapping equipment was installed and/or removed from the line. A printout 38 could then be employed to signal the necessity to take corrective steps.

In summary, employing a tone generator 10 that uses a frequency of 20,000 hertz or greater provides a more accurate reading than existing commercially available devices, and in addition is not detectable with current commercially available tapping equipment. Thus, if some agency should be tapping a user's telephone line, the agency would not be aware that the inventive system is being employed for detecting the unauthorized tapping.

With reference to Figure 4, there is shown an electrical schematic of a preferred embodiment according to the present invention. The major components are shown enclosed in phantom lines, such as a tone generator 10, a signal detector 20, a 9-volt power supply 42, a dual RJ 14 female connectors 44 for connection to the telephone loop, an RMS to DC converter 46, and a switching arrangement 48.

It should be noted that the tone generator 10 provides for a tone selection from 32K to 51.1K using a plus 5 volt power source. In addition, the resisters are 1% tolerance.

In the signal detector 20, there is shown an LCD display, digital panel volt meter 22 which is connected to a potentiometer 49 with a plus 9 volt power supply 42. To the right of the display 22, there is shown a push button switch 50 for momentary monitoring the phone line. A down regulator voltage converter is also provided to render consistency in measurement in lesser voltage draw from the battery supply.

It should be noted that a miniature pushbutton switch 1 is provided to the telephone line to prevent foreign circuit noise winding up or down when powering up or turning the apparatus off.

Numerous modifications, variations, and adaptations may be made to the described embodiments without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A method for detecting a discontinuity in a telephone line and the distance of the discontinuity from a testing device connected to said line, the line comprising of a pair of twisted wires between the test location and the discontinuity location to fault, said method comprising the steps of:

generating a test tone at a test frequency and applying said test tone to the telephone line at the test location;

measuring the frequency loss in the telephone lines by comparing the reflected frequency to a base frequency;

calculating the distance from the test location to the discontinuity location according to the formula D equals frequency lost times loss per foot, where D is the distance between the test location and the discontinuity location and the frequency loss is a difference between the test frequency loss and the actual frequency loss times the loss per foot.

2. A method as defined in claim 1, in which the tone is generated at a frequency in excess of 20,000 hertz.

3. A method as defined by claim 1, in which the fault is a discontinuity in the telephone line.

4. A method for detecting the authorized connection to a telephone line comprising the steps of:

generating a test tone at a test frequency and applying the test frequency to the telephone line;

measuring the frequency loss in the telephone line from the test frequency to establish a base frequency loss;

generating the test tone at the test frequency to the telephone line and comparing the frequency change to the base frequency of the loss.

5. A method as defined in claim 4, including the step of determining if the frequency change reflects a drop or gain with respect to the test frequency loss.

6. A method as defined in claim 4, including the step of calculating the location of the circuit in which the tone is generated to the location of the unauthorized tapping according to the formula:

D equals FL times frequency loss per foot.

7. A method as defined in claim 4, in which the tone is generated at a frequency of at least 20,000 hertz.

8. A method as defined in claim 5, in which the telephone line has copper wire and the tone is generated through the copper wire.

9. A method as defined in claim 4, including the step of generating an alarm signal if the frequency change exceeds a predetermined value.

10. A method as defined in claim 7, including the step of continuously generating the tone, and monitoring the frequency loss to determine the time of a temporary tapping in the telephone line.

11. Apparatus for determining an abnormal condition of a telephone line, including:

first means for applying to said telephone line a signal having a frequency of at least 20,000 hertz;

second means for determining a reference decibel loss in said telephone line under normal conditions when said signal is applied to said telephone line;

third means for determining an abnormal decibel loss to said telephone line caused by said abnormal conditions when said signal is applied to said telephone line; and

a difference between said reference decibel loss and said abnormal decibel loss indicating said abnormal condition of said telephone line.

AMENDED CLAIMS

[recceived by the International Bureau on 30 November 1998 (30.11.98); original claims 2 and 7 cancelled; original claims 1, 4 and 10 amended; remaining claims unchanged (3 pages)]

1. A method for detecting a discontinuity in a telephone line and the distance of the discontinuity from a testing device connected to said line, the line comprising of a pair of twisted wires between the test location and the discontinuity location to fault, said method comprising the steps of:

generating a test tone at a test frequency in excess of 20,000 hertz and applying said test tone to the telephone line at the test location;

measuring the frequency loss in the telephone lines by comparing the reflected frequency to a base frequency;

calculating the distance from the test location to the discontinuity location according to the formula D equals frequency lost times loss per foot, where D is the distance between the test location and the discontinuity location and the frequency loss is a difference between the test frequency loss and the actual frequency loss times the loss per foot.

3. A method as defined by claim 1, in which the fault is a discontinuity in the telephone line.

4. A method for detecting the authorized connection to a telephone line comprising the steps of:

generating a test tone at a test frequency of at least 20,000 hertz and applying the test frequency to the telephone line;

measuring the frequency loss in the telephone line from the test frequency to establish a base frequency loss;

generating the test tone at the test frequency to the telephone line and comparing the

frequency change to the base frequency of the loss.

5. A method as defined in claim 4, including the step of determining if the frequency change reflects a drop or gain with respect to the test frequency loss.

6. A method as defined in claim 4, including the step of calculating the location of the circuit in which the tone is generated to the location of the unauthorized tapping according to the formula:

D equals FL times frequency loss per foot.

8. A method as defined in claim 5, in which the telephone line has copper wire and the tone is generated through the copper wire.

9. A method as defined in claim 4, including the step of generating an alarm signal if the frequency change exceeds a predetermined value.

10. A method as defined in claim 4, including the step of continuously generating the tone, and monitoring the frequency loss to determine the time of a temporary tapping in the telephone line.

11. Apparatus for determining an abnormal condition of a telephone line, including:

first means for applying to said telephone line a signal having a frequency of at least 20,000 hertz;

second means for determining a reference decibel loss in said telephone line under normal

conditions when said signal is applied to said telephone line;

third means for determining an abnormal decibel loss to said telephone line caused by said abnormal conditions when said signal is applied to said telephone line; and

a difference between said reference decibel loss and said abnormal decibel loss indicating said abnormal condition of said telephone line.

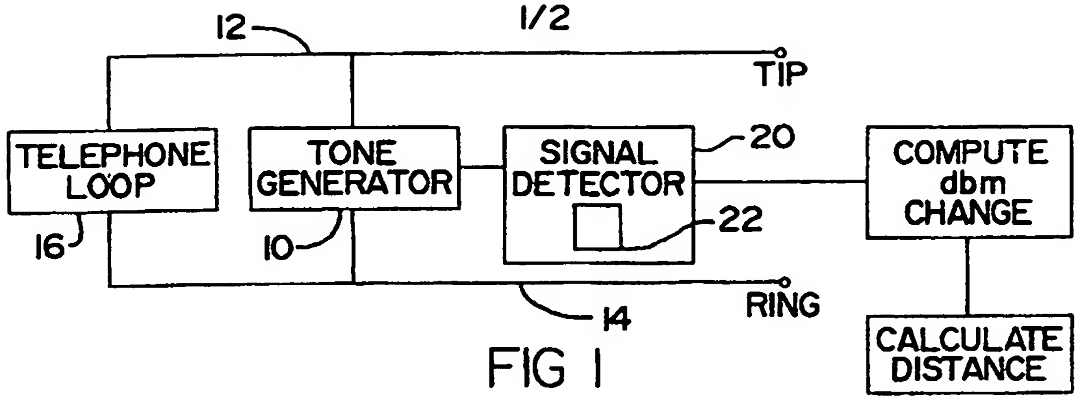
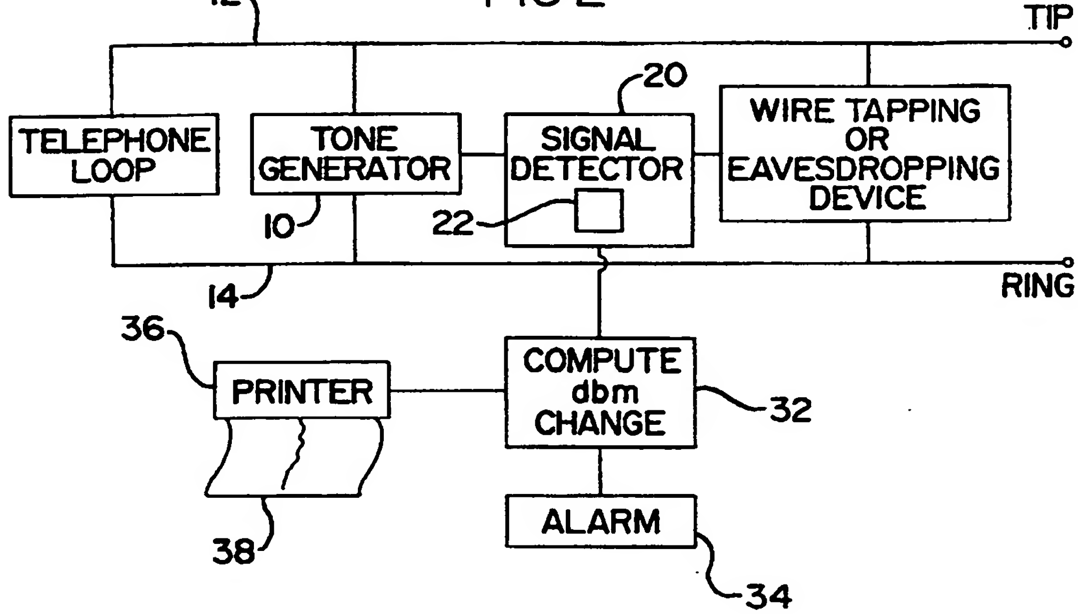


FIG 1

FIG 2



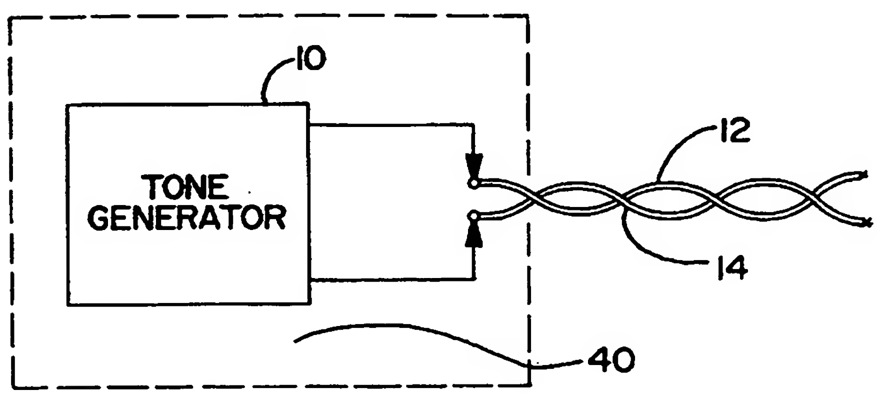
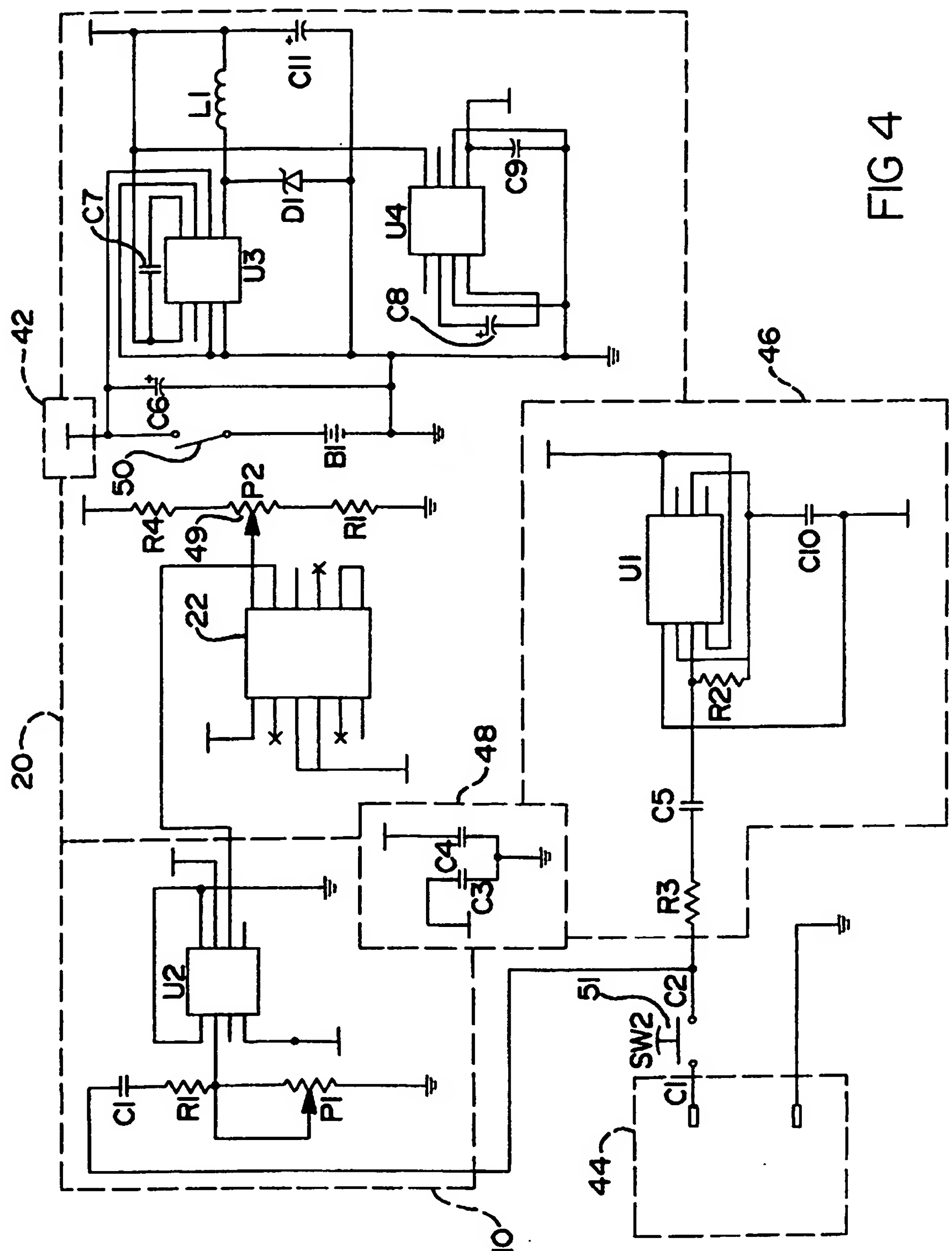


FIG 3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L1
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C7
U3
U4
C9
C8
C6
B1
R4
P2
R1
U1
C10
R2
C5
R3
C4
C3
U2
C1
R1
P1
SW2
C2
C1

FIG 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/06797

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04M 1/00
US CL :379/7, 6, 24, 5, 32, 26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/1, 5, 30, 34, 35, 7, 6, 24, 5, 32, 26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,229,626 A (PEOPLES) 21 October 1980, see abstract and figure 3.	1,3-6, 8-10
A	US 4,634,813 A (HENSLEY) 06 January 1987, see abstract.	1-11
A	US 4,680,783 A (BOECKMANN) 14 July 1987, see entire document.	1-11
A	US 5,099,515 A (KOBAYASHI et al) 24 March 1992, see entire document.	1-11

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "P" document published prior to the international filing date but later than the priority date claimed
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- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

20 JUNE 1998

Date of mailing of the international search report

28 SEP 1998

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